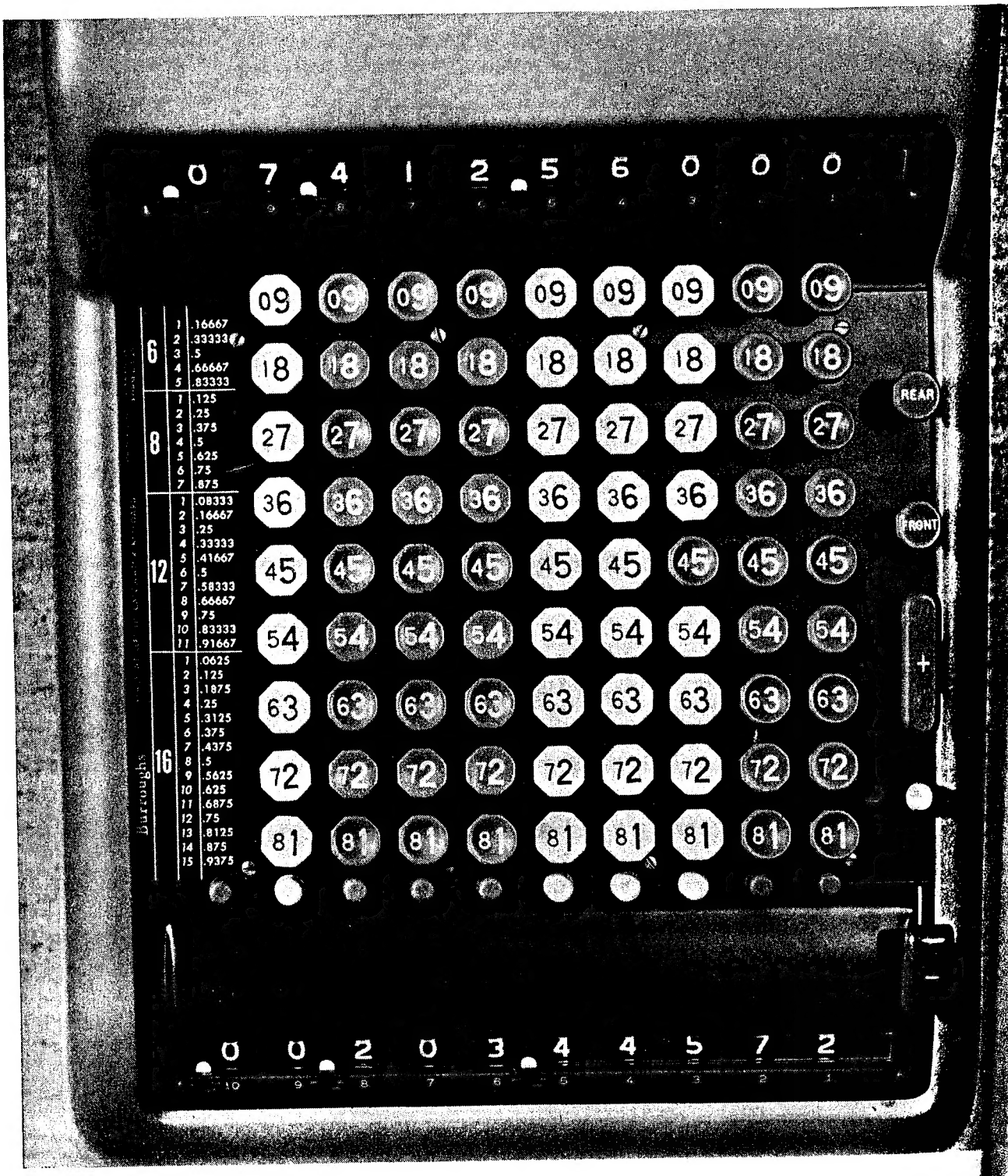
BY THE NUMBERS



THE HARDEST WORKERS IN THE OFFICE ARE THE ADDING MACHINE AND THE DESK-TOP CALCULATOR

IF YOU OWNED A WORKHORSE, where would you put it? In a stable? In the garage? Chances are, like most successful office administrators, you would put it on top of a desk.

Until the day when the completely automated office becomes a reality, the real workhorse of everyday business activity continues to be the desk-top adding and calculating machine. Literally thousands of man-hours per week are saved through the efficient use of these machines. They are such a common part of modern office equipment that we now tend to take them for granted.

Like most things that we take for granted, it is sometimes difficult to define precisely just what it is. It is relatively easy to state the difference between a calculator and a desk, but when we must subdivide business machines themselves, the words begin to get sticky. How exclusive shall we make our definitions when comparing the differences between an adding machine, a calculator, and a computer?

A competitive field

The production of adding and calculating devices is a highly competitive field. Continuous technological research provides the consumer with a choice of machines that is being constantly enlarged and improved. Many of the improvements made to existing models are extremely technical in nature. Consequently, the layman consumer, who has only a vague appreciation of electrical or mechanical engineering, is often confused by the meaningful (if overly detailed) claims made by competing manufacturers. He tends to make general machine comparisons either in terms of pure theory or relative to the specific business task that he wishes the machine to perform. Rarely does he consider all the details.

Information processing

Let us first use the term calculating machine as a general classification. A calculating machine then is basically an information processing system. This system deals primarily with numerical information, and is primarily concerned with performing arithmetical operations on it.

The essential difference between the many types of calculating machines lies in the form in which the information is stored and the manner in which it is presented. We are all familiar with two general types of arithmetically oriented information systems: the continuous machine and the digital machine. To use a well known example, a continuous type of machine may be represented by an automobile speedometer. The digital type of machine is then seen as the auto odometer which records distance traveled.

High precision

Office calculating machines are of the digital type, and for a very good reason. The inherently high precision of digital machines makes them more suitable for the performance of extended operations on a set of data. It is much easier to avoid an accumulation of errors on a digital machine than on a continuous one.

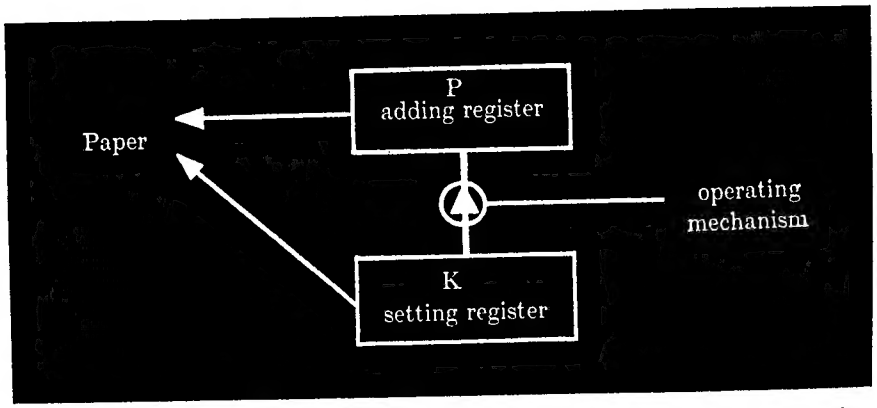
Continuous machines are used where a fairly low level of precision is sufficient. The manner in which the information is presented on a continuous machine, leaves much room for possible error because it demands a degree of intelligent estimation by the recipient of the information. The speed of an automobile, for instance, is represented by the angular position of a pointer that is measured from some arbitrary zero position on a scale. The needle wavers, the driver looks, makes a mental estimation of mean speed traveled, and eases his foot from the gas pedal.

On the odometer, the digital machine, the number of miles traveled

Digital machines, employing a discrete method of recording data, are better suited for use in office tabulations than continuous recordings that require interpretation.

ADDING MACHINES

Small, compact models continue as most popular desk-top companion



Most adding machines have two functional registers. A number that is set in register K is added to the contents of register P each time operating mechanism is triggered.

. . . continued

is represented by one or more quantities, each of which can take up only one of a finite number of values. There are four number wheels on the odometer. These number wheels can at any one time take up only one of 10 angular positions relative to the window through which the total figure is read. All digits of the number are read off directly by the driver. There is no question of estimation between scale divisions. Assuming that our scale is correct and our recording device accurate, the operator may record the distance of his trip with a fairly sure sense of accuracy.

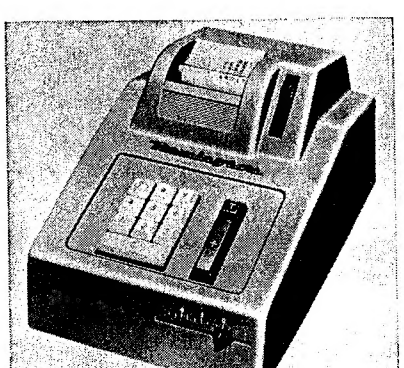
The information handled by a calculating machine is for the most part of two sorts: numbers, by which we mean the data, usually numerical in form, which the machine is being used to process; and instructions, by which we mean the information passed to the machine from the operator to define the processes which the machine should carry out on the numbers.

The classical trinity

The three classical elements of a calculating machine were first defined by an Englishman named Charles Babbage over a hundred years ago. Babbage, who lived from 1792 to 1871, was an English inventor and mathematician. He devoted most of his life and expended much of his private fortune, as well as a government subsidy, on an attempt to develop an "analytical engine." He was less than successful in his personal ambition, but the theoretical basis of his work continues to be a valid means of definition for the modern calculating machine.

Babbage, who later founded the Royal Astronomical Society, divided his "engine" into three theoretical components. He called them respectively *the store, the mill,* and *the control.* Any computing system, however simple or complex, may be analysed within this conceptual system and divided into the same components. With the smaller machines, it is sometimes necessary to consider the operator and his work sheet as part of the system, but granting this extension, the theory continues to be modern.

To slightly paraphrase the original terms used by Babbage, we find that the store refers to a memory or storage capacity inherent to the machine. The simpler types of machines may locate this storage capacity partly in the work sheet on which processed answers are copied



REMINGTON RAND, Model 8, portable adding machine fits almost anywhere on compact 6" x 10" base. Lists 8 figures, totals 9 on paper tape for permanent record. Transparent paper cutter keeps all figures visible at all times to operator. Simple keyboard design makes for speed and ease in handling. Has correction lever and column indicator. Electric. Wt. 9 lbs. Carrying case available. $79.50.

R. C. ALLEN, Model 8/10 adding machine includes an 8-place column indicator repeat key for duplicate entries, direct subtraction, automatic totaling, automatic clear signal, separate sub-total key, automatic double space after printed total, thumb operated clearance lever and a visible constant total above the keyboard. Ten-key keyboard offers easy touch operation. Machine electrically powered.

NATIONAL CASH REGISTER, 10[illegible] adding machine provides complete [illegible] touch operation. Includes automatic [illegible] over" multiplication, single function [illegible] direct totals. Quiet, compact unit is [illegible] able in choice of 5 pastel colors. [illegible] battery-powered model (with [illegible] power unit fitted onto back of [illegible] model) will soon be in full production [illegible] $80 more than standard cost. $295[illegible]

Basically, however, this storage capacity is made possible through the use of *registers*.

All calculating machines contain one or more registers, mostly numerical registers, which form part of the machinery. A register is a set of number wheels and levers which holds a figure. All adding and calculating machines have at least one register, while the models that have been designed to perform complicated calculations may have as many as four. Each register is capable of holding a figure, then applying it to other registers for further calculation. It is possible on some of the newest machines to clear one half of the calculation and preserve the other because the machine includes a split register. With this technique, the operator can show totals in one half of the machine process and accumulate them in other areas.

The operational part

Every calculating machine also includes some means of performing operations or groups of operations on the data that has been stored in the registers. It is this capacity for performing operations and the active performance of those operations that is referred to as the mill. Typically, each operation results in the replacement of a number in a particular register with a function of a number or numbers (as defined from operator's instructions) that has been located elsewhere in the machine. These new numbers may have been stored in other registers or, possibly, in the same register into which the introduced function is to be placed.

The essential control

Finally, an essential part of a calculating machine is some means of control over the operation to be performed. It is this control factor that actually selects the operations relative to the numbers in storage and task for which the machine is being put to use.

Within this component theory of the "analytic engine," we can approach some definition of the types of calculating devices available to the business consumer. The differences between the machines themselves appears to be largely a quantitative one, dependent upon which of the elements is to be emphasized. We have three basic areas of possible concentration: storage, operation, and instruction. Though the dividing lines are somewhat variable and entirely arbitrary, we can safely say that gradation from adding machine, through calculator, to computer, moves through phases of concentration which respectively emphasize first storage, then operation, then instruction capacities of the machine.

Four basic types

There are four basic types of desk-top calculating machines in daily use in most administrative offices:

1. adding machines
2. printing calculators
3. rotary calculators
4. key driven calculators

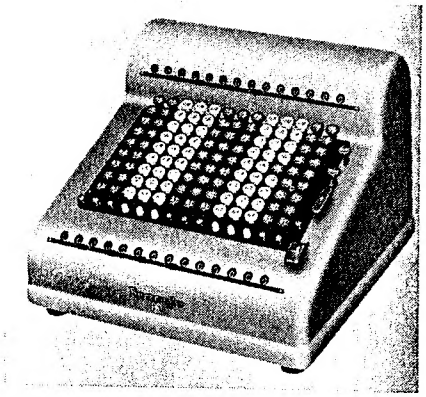
Adding machines are designed for the express purpose of performing the relatively simple arithmetical functions of addition and subtraction. The capacity to perform more complex operations like division, squaring and extracting roots, is not included in the mechanical structure of the machine. Adding machines can be made to perform multiplication, but this is achieved through the relatively crude method of repeated addition. Results of the operation are printed on a thin paper tape which then becomes an extension of the storage capacity of the machine.

Those that print

Printing calculators also perform simple addition and subtraction. These machines are designed with the more complex arithmetical operations in mind. They are capable of multiplication and division, and therefore can be applied to a much wider range of business functions. Many of these machines are able to carry a credit balance, manipulate fractions, carry a constant from one phase of operation to another, do negative multiplication and automatic squaring of figures. The

INTEREST "Sprint" adding machine is distributed by Alma Office Machines Corp. Ten key adding machine is equipped with automatic credit balance and subtotals. Fast, compact electric operates at speed of 220 printed entries per minute. Available in three capacities: 8 entry/9 set, 10 entry/11 total; 12 entry/13 set. Keyboard design makes for speedy touch operation. Heavy duty design.

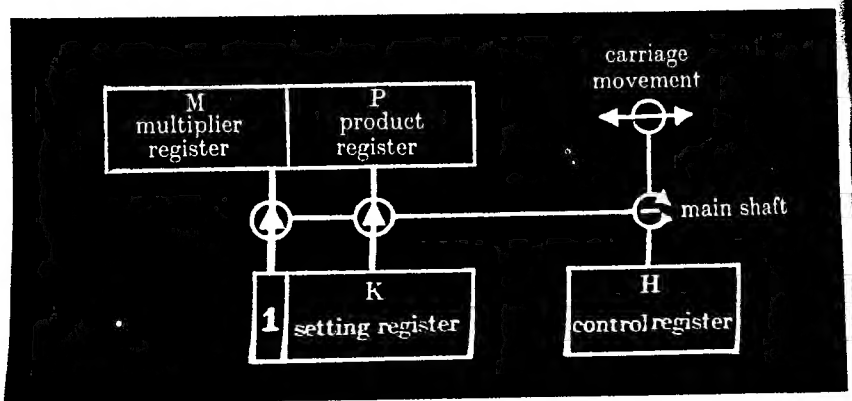
VICTOR "Premier" adding machine employs three motor bars to eliminate non-essential hand movements. Every functional key on the 10-key keyboard is placed within operator's easy reach to facilitate "speed touch" operation. Located in a vertical row, the length and position of each bar has been carefully determined according to the functions most frequently used by average operator.



BURROUGHS, Model C305, key driven calculator lists 13 columns, totals 14 columns. Numerical value is instantly added to amount in the machine without the need to use motor bars or levers. Electric, key driven operation increases speed of handling in large volume figuring jobs. Two totals are provided to operator, with separate total clearance. Direct subtraction is additional feature.

CALCULATORS

More complicated business functions are best performed on bigger machines



More complex calculators may have as many as four registers as standard equipment.

. . . *continued*

most advanced and complex models also offer a capacity to automatically provide operators with square roots of numbers when such function is desired by the particular task to be performed. The machines take their name for the practice which they share with adding machines, in that they consistently print the results on a paper tape.

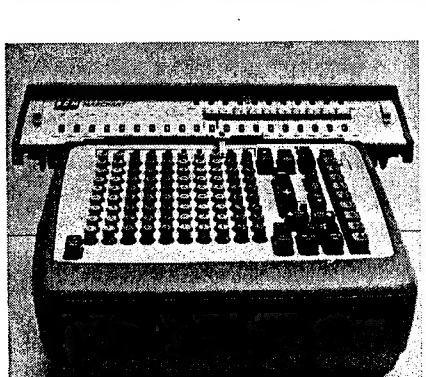
Rotary calculators do not list or print numbers. Instead, they show the results of calculations in rows of rotating number dials. Rotary calculators may be used to do ordinary addition and subtraction, but they are more efficiently disposed when directed to high speed multiplication and division problems for which they have been designed.

Key driven calculators do not list or print numbers on paper tape. The results, like results of rotary calculators, are shown on visual number dials. Key driven calculators are of a full keyboard design. They are particularly suited to high speed addition and subtraction because the operator can enter all the digits of the number to be processed at the same time. It requires, then, less time for the operator to instruct the machine. Given extended operations over a considerable length of time, substantial time savings thus become evident to the operator. The instant that the keys are depressed, the result shows up on the visible dials. Multiplication and division are performed by repeated addition and subtraction. The newer models of key driven calculators are provided with a separate multiplier key.

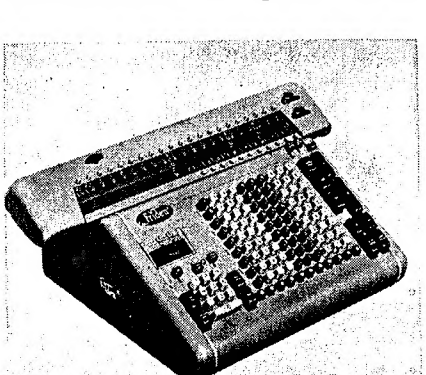
Subdivide for clarity

It is convenient to further subdivide office, desk-top calculating machines by the keyboard design used in the particular model. There are two basic types of keyboard: the ten key, and the full keyboard types. In terms of its theoretical function, this division may seem comparatively trivial in that it relates only to an external difference. This difference however, is extremely important when considering the applied usages of a particular machine. The two methods of construction, ten key and full keyboard, offer definite advantages that are mutually exclusive. The choice of keyboard, when it is not a matter of mere personal taste, is otherwise decided by the particular principle function that the consumer wishes to perform.

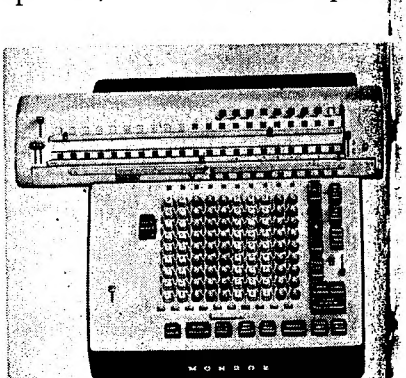
The proponents of each type of keyboard naturally claim advantages. The ten key keyboard is apparently more convenient for the operator, in that it makes possible



SMITH-CORONA MARCHANT, Model CMF, rotary calculator operates at 1300 revolutions per minute. Features three dial, straight line proof for step-by-step accuracy check. Includes special division feature for computing percentage of decrease; automatic decimals; and automatic round off. Slimmer key tops increase space between keys for easier keyboard mastery. Ten column figure capacity. $925.



FRIDEN, Model SRQ, rotary calculator includes recently introduced automatic squaring features. Square root and squaring are accomplished at touch of a single key. Other features include automatic reentry of root, automatic division with automatic decimal point, automatic tabulation, split dial clearance and dial locks for accumulation, and automatic dial clearance and carriage positioning.



MONROE, Model IQ-213, rotary calculator features exclusive memory dials completely automatic division and multifactor multiplication. Memory dials eliminate the need to reset constants the keyboard. Figures can be stored recalled by the operator at any without interfering with other additi subtraction, multiplication, and divis operations. Automatic decimal point

a touch system of operation by the user. Since all the keys fall conveniently in a small space, it is relatively easy for the operator to learn the keyboard by touch.

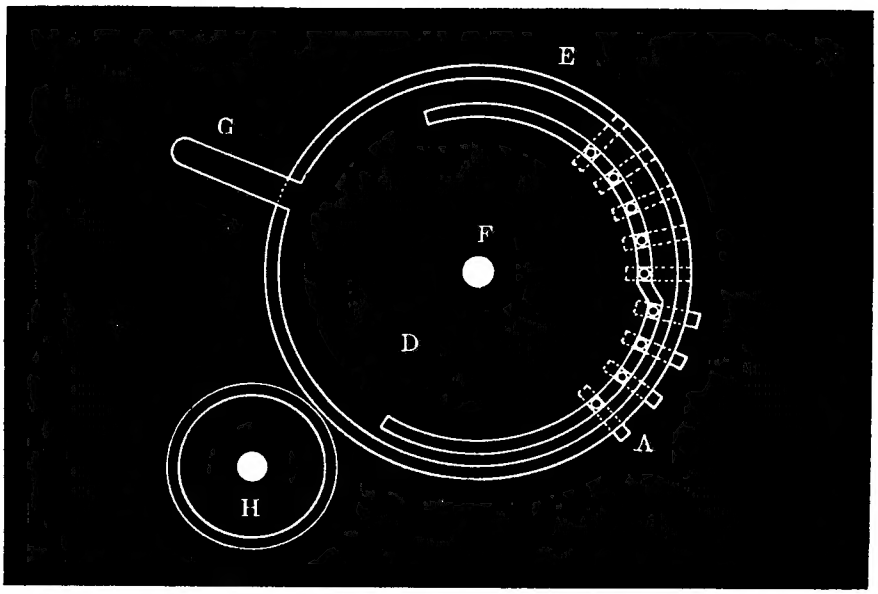
Ten key keyboards

Ten key machines have just one key for each digit from zero thru 9. The operator follows a set finger pattern on the keyboard, developing a touch system, performing his function with greater speed. Working with a touch system of instruction, the operator need not take his eyes from the listed data that he is feeding into the machine. Some ten key models are equipped with a double or triple zero key to speed entry of the larger numbers.

Full keyboards

Full keyboard machines have a row of keys from 1 thru 9 for each digit in a number. Because of the large number of keys on the keyboard, operators do not usually employ any kind of touch system when feeding information and instructions to the machine. Whether or not this constitutes basis for the claim that the ten key models are faster is questionable because, using the full keyboard model, the operator does not have to depress a key to record a zero. All zeros which occur in the number must be entered by pressing a zero key on the ten key models. On the full keyboard, the number of zeroes is determined by the column in which the key to be depressed is located.

Correction of a single wrong digit is easier to accomplish on a full keyboard machine, but multiplication is usually not so convenient. Almost all nonprinting calculators have full keyboards. There are, of course, the usual exceptions to prove the rule. Some of the newer full keyboard calculators are provided with a ten key auxiliary keyboard to be used when it is desired to perform rapid multiplication.

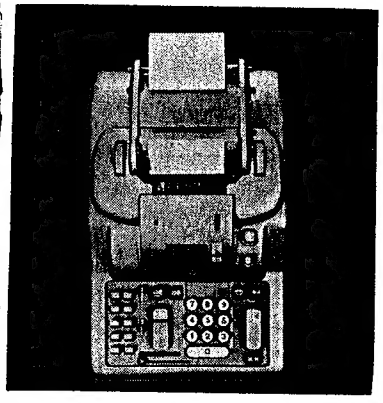


One of the more common methods of operation employed in rotary calculators is that known as the Odhner wheel. A number of wheels or discs (E) rotate with the main shaft (F). A second set of wheels (D) is rotated by means of a setting lever.

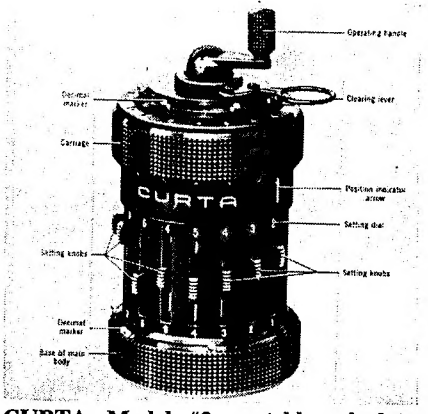
The office manager is sometimes confused by the many possible arithmetic functions that are advertised by the machine manufacturer. Unless he has a fairly intimate background in mathematics or machine technology, it is possible that terms like "negative multiplication" might seem meaningless.

Negative multiplication

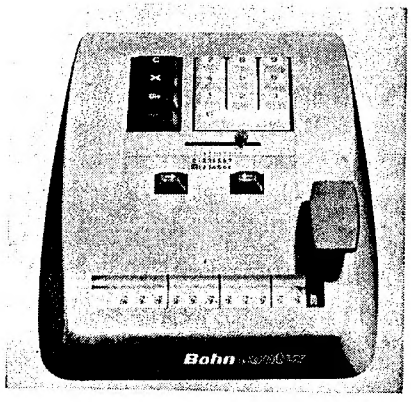
Negative multiplication refers to a capacity of the machine to perform multiple separate functions on a stored number. The machine mul-



ADDO-X, Model 4541, printing calculator has direct division, constant key, automatic ultra short-cut multiplication, positive or negative, prints multiplicand, multiplier and product. Automatic division feature is high speed and prints dividend, divisor, quotient and remainder. Printing of all arithmetical elements provides constant check for operator. Grand total feature also included. Price of machine $500.



CURTA, Model #2, portable calculator weighs only 12 ounces and is small enough to fit into operator's hand. Performs all arithmetical functions accurately including division, squares, root extraction, accumulative multiplication and division by constant factor. All answers direct. No scales to read. Special feature provides operator with selective clearing. Weatherproofed, shock-proof design. $165.



BOHN "Contex" calculator is designed for speedy touch operation. Actuating bar is depressed without removing fingers from keyboard. Lists 10 digits, totals 11. Ten-key machine weighs only 6 lbs. Automatic decimal point in division. Sub-totals continuously available in multiplication. Answers appear on register at base of machine, as soon as last figure is entered. Fits into desk drawer or brief case. $125.

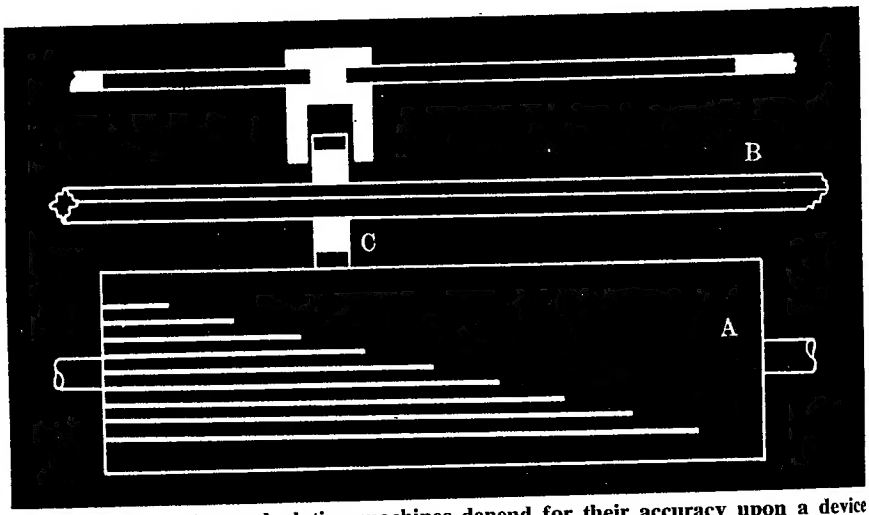
. . . *continued*

tiplies two quantities, and at the same time subtracts the result of the multiplication from an amount that has been stored in the product register. This can be an extremely important, time-saving function of the machine when the work to be accomplished requires complicated arithmetical combinations.

The simplest machine

It is hard to imagine, when considering the immensely complicated machines that are now readily available, that quite difficult arithmetical functions can actually be performed on a machine having only one numerical register without any acillary devices. Such a machine, however, does exist and is used by a great many skillful operators in the Far East.

The machine is called the abacus. When the abacus is used by a skilled practitioner, he can make calculations much faster than the usual pen-and-paper method. In some kinds of work it is possible to achieve results faster with an abacus than with a slide rule. The methods employed in the construction of an abacus are strikingly similar to those used in the most modern calculating machines.



A number of modern calculating machines depend for their accuracy upon a device known as the Leibnitz wheel. This is a rather complicated mechanical construction which consists of nine teeth of unequal length fixed to a central shaft. Each tooth represents a different unit in the decimal order. Variation in length and position of shaft during operation determines what is to be the function in operation of the machine in a given circumstance. Tens transmission, as with Odhner wheel, is in serial manner.

The abacus consists of a rectangular frame which holds a number of rods. A transverse bar divides these rods into two unequal portions. Beads are used to indicate numerical values relative to their placement on either side of the dividing bar.

On one side of the bar the beads may represent units of one. On the other they will represent units of five. Long numbers are formed by combining the unitary differences of the two. The register is cleared by sweeping the fingers along the rods and pushing all beads away from the dividing bar.

This system of combining units of different values in order to construct a more complex figure is called the biquinary notation. It is a principle that forms one of the fundamental methods employed in today's most advanced machines.

Pascal's stylus

Another simplified version of the modern calculating machine is the type of machine that is stylus-operated. It was this general type of machine that was first invented by Blaise Pascal in 1642, and has gained for him the rightful title of the father of modern machine mathematics.

The stylus machine, later developed into the "arithmographe," employs a number of free-sliding strips on a fixed frame. Each strip represents a different decimal order. The notched strips are marked for face value and, by a series of pulls, pushes, and scale manipulations, the machine can provide the user with amazingly accurate and speedy answers to elaborately complex mathematical problems.

In addition to the printed tape that is standard equipment for adding machines and printing calculators, some machines are equipped with a variation of a typewriter carriage that enables the operator to post processed data directly onto forms and reports. These machines, since they combine a number of functions that are not strictly, nor even primarily, arithmetical, are considered as a group apart from the standard calculating machine. They are usually classified under the general heading of accounting machines, because this is the area of their most fruitful application.

Some printing calculators and rotary calculators offer the operator the possibility of making repeated multiplications without pausing to re-enter the product to be multiplied each time the operation is to be performed. This capacity is known as automatic re-entry. The machine multiplies two quantities, then holding a constant multiplier, applies a second or third multiplication to the product of the first multiplication.

The automatic square

Automatic squaring refers to a function of the machine that automatically multiplies any number by itself. The operator who wishes to find the square of a number need only enter one figure on the keyboard, then push a squaring key for his results. The alternative would be a second insertion of the figure and an initiation of the multiplying action.

When it is said that a machine has an automatic constant, the operator is to understand that the machine is capable of storing a number in one of its registers for use in repeated calculations. This relieves the operator of the necessity to re-enter the same number over and again each time he wishes to use that number in his work.

Some machines may be set to automatically round off the results of processing to the nearest whole figure, or to a chosen decimal place. A number of machines are available that automatically place the decimal point in an answer, thereby making it unnecessary for the operator to do this mentally. As a general rule, the less work required

. . . *continued*

by the operator, the lower is the possibility of error.

Although the great majority of the adding and calculating machines that are produced for the modern market are electrically powered, there are still many areas where the hand-operated mechanical calculator is extremely useful.

Hand machines are naturally cheaper than electrically powered machines. They are also less prone to the occasional mechanical faults that may appear in any highly complex instrument. Because they do not depend on any required electrical outlet in order to perform their function, they are obviously much more portable. Hand machines have been constructed that are actually miniature calculators.

Doing it by hand

Where it is important for a large number of people to have a machine near at hand for immediate use, but where the volume of work is insufficient to keep each machine occupied for more than a small proportion of the time, a hand operated machine is usually sufficient to business needs of the consumer. Hand machines also provide a useful standby in case of power failure or mechanical difficulties in larger, electrical machines. Though work will progress slower than usual during the period of hand use, work will nonetheless be accomplished and a complete stoppage of activity will be avoided.

Somewhere along the scale from a simple, one register, hand-operated adding machine to the fully automatic, computer-like calculator with many registers, is a machine that is specially designed to perform every conceivable kind and combination of business arithmetical function. The choice of the right machine can save thousands of hours for the fortunate owner.

But, sophisticated as it might be, the office calculator is still a workhorse. And if the day ever comes when it is no longer needed, I guess that day might even be a sad one. Particularly for those of us who saved all that cash. ■

THE COMPANIES LISTED BELOW can supply readers with any additional information they may require on the subject of adding and calculating machines. Circle matching numbers on reader inquiry card.

ADDO-X, INC., 300 Park Avenue, New York 22, N. Y. (101)

R. C. ALLEN BUSINESS MACHINES, INC., 678 Front Ave., N. W. Grand Rapids 4, Mich. (102)

ALMA OFFICE MACHINE CORP., 349 Broadway, New York 16, N. Y. (103)

BOHN BUSINESS MACHINES INC., 444 Park Avenue South, New York 16, N. Y. (104)

BURROUGHS CORPORATION, 6071 Second Blvd., Detroit 32, Mich. (105)

CALCULATOR EQUIPMENT CORP., 556 Central Ave., Orange, N. J. (106)

COMMODORE BUSINESS MACHINES CO. 113 West 42nd St., New York, N. Y. (107)

CURTA COMPANY, 14435 Cohasset, Van Nuys, Cal. (108)

DASHEW BUSINESS MACHINES, INC. 3655 Lenawee Ave., Los Angeles 16 Cal. (109)

FACIT, INC., 404 Fourth Avenue, New York 16, N. Y. (110)

FRIDEN, INC., 2350 Washington, San Leonardo, Cal. (111)

MONROE CALCULATING MACHINE CO. INC., 555 Mitchell St., Orange, N. J. (112)

NATIONAL CASH REGISTER CO., Main K Streets, Dayton 9, Ohio (113)

OLIVETTI CORP. OF AMERICA, 373 Park Avenue, New York, N. Y. (114)

REGNA CASH REGISTER CO., 175 Fifth Ave., New York 10, N. Y. (115)

REMINGTON RAND, Div., of Sperry Rand Corp., Office Machines Div., 315 Park Avenue, New York 10, N. Y. (116)

SMITH-CORONA MARCHANT INC., 4 Park Avenue, New York 22, N. Y. (117)

SWIFT BUSINESS MACHINE CO., Grove Barrington, Mass. (118)

UNDERWOOD CORPORATION, One Park Avenue, New York 16, N. Y. (119)

VICTOR BUSINESS MACHINES CO., Div. Victor Comptometer Corp., 3900 N. Rockwell St., Chicago 18, Ill. (120)